FOODS AND BEVERAGES
426/29

REPRINTED FROM
ORIGINAL COMMUNICATIONS, EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY. Vol. XXVI—Page 77

THE QUALITATIVE REGULATION OF THE EXTRACT OF BEER-WORT AND BEER IN BREWERY PRACTICE

Carl Rach,
Staten Island, N. Y.

The Beer production in all countries of the world is steadily increasing and amounted during the last year to approximately 250,000,000 barrels. The consumption of beer in the United States of America has practically doubled within the last 20 years. In England, Germany, Austria, France and Belgium, it is steadily rising. If we figure approximately 50 lbs. of malt or malt and unmalted cereal and ½lb. of hops per barrel of beer, the production of 250,000,000 barrels of beer for the world's use would require 12,500,000,000 pounds of starchy brewing material and 125,000,000 pounds of hops. This vast amount of raw material must be produced by agriculture. It keeps the farmer continually busy and brings him the corresponding financial returns. The brewing industry occupies an eminent place among the industries of the civilized countries and a great number of allied industries are employed by it in the most profitable manner. The manufacture of beer creates means of existence for a whole army of men. These conditions clearly define the position of the brewing industry from the standpoint of political economy. The brewing of beer is of the greatest advantage however to the individual, giving him a healthy, pure, palatable, refreshing and nutritive food beverage. No other product is of such uniform and unvarying quality, and this explains its popularity. A glass of beer and a piece of bread, although very modest, represent a meal which satisfies both hunger and thirst.

The brewing industry produces two great types of beer, one by "top" and the other by "bottom" fermentation, according to the kind of yeast employed and the temperatures maintained. Types of top-fermented beers are English and American ale,

stout, and porter, Belgian beer, German and Danish top-fermented beer, Weiss beer, Australian beer, etc. About one third of all the beer produced is "top" and two thirds "bottom" fermented. The main types of "bottom" fermented beers are the following: Bavarian beers, (Munich, Nurnberg, Erlangen, Kitzingen), Bohemian beers, (Pilsen), Austrian beer (Vienna), Dortmund beer, Carlsberg beer (Copenhagen), and Strasburg beer, Lager beer of the United States, etc. England, its colonies and Belgium mostly consume "top" fermented beers, whereas Germany, Austria, France, Switzerland, and the United States are the principal consumers of "bottom" fermented beers.

Beer is made from hopped beer-wort produced by the mashing and brewing processes. The average quantity of raw material employed for the production of a barrel of hopped beer-wort containing from 32 to 35 lbs. extract is approximately 50 lbs. made up of malt or malt and unmalted cereals and ½lb. of hops. The main qualities of the beer-wort necessarily depend upon the kind and quality of the raw materials and the method of brewing them. It is a fact that in all countries where large amounts of beer are consumed, as for instance in Bavaria, the quantity of hops used per barrel, or hecto-liter of beer, is comparatively small. The quality of hops naturally varies and it may be said of the best varieties that they are to beer what spices are to other foods. Strongly hopped beers are not regarded with much favor. One hundred parts by weight of hops do not impart to the beer-wort any more than twenty parts by weight of extract; the amount of hop extractives in the finished beer may therefore be regulated by the amount and quality of hops added. The analytical results show that those types of hops known as "choice" (edel) contain less hop-oil, less hop resin, less hop bitter acids and tannic acids than the common types. Therefore beer *produced from the use* of "choice" hops contains less hop extractives than beer brewed with common hops.

Much more important than the hop extractives are those constituents of the beer-wort and beer which are derived from malt or malt and unmalted cereals by the mashing and brewing processes. Let us study a 12° B. wort, containing 32½lbs. of extract by weight in one barrel. Its chemical composition must be of

the greatest interest to the practical brewer because it determines the taste, the palate-fulness, the alcohol content, foam keeping quality, color, brilliancy, etc. of the finished beer. The extract may contain various ratios of sugar to non-sugar, sugar to dextrin and of sugar to the soluble nitrogenous constituents. The ratio of sugar to non-sugar in the wort determines the alcohol content of the finished beer, a fact of main importance. The production of beer has developed immensely with the introduction and use of steam in place of direct fire boiling. Before that time beer was produced in many small breweries and in the family copper. But the small breweries have been replaced in all countries by fewer and larger breweries producing many million barrels of beer annually.

As an article of consumption, as a food beverage of the masses, beer is recognized by the governments of all civilized countries and used by them as a source of revenue by high and strictly enforced taxation.

Looking over the tables of beer analyses for the last fifty years, we observe that the heavy gravity beers of old have been displaced by beers of lighter gravity, and that the percentage of alcohol has steadily decreased. Progress in modern chemistry and physiology has taught the brewer not to waste the valuable extractive food constituents of the beer-wort unnecessarily during the fermentation. During this process, the general rule prevails that two parts of malt sugar produce one part of alcohol and one part of carbonic acid gas. If a portion of the fermentable malt sugar is displaced by unfermentable extract, the formation of alcohol and carbonic acid is proportionately decreased. We necessarily require malt sugar in the beer-wort because without it there would be no fermentation and consequently no alcohol or carbonic acid gas, both of which are necessary and normal constituents of finished beer. There is a growing tendency among brewers to produce ordinary draught beers with not more than 3% of alcohol. This may be done by making 10% Balling wort, but is impossible, if worts of 12 B. or more are employed. How can we avoid lowering the extract in the wort if we must decrease the alcohol of the finished beer? If two parts of sugar produce one part of alcohol, we should have in a

12% wort no more than six parts of fermentable sugar, and must therefore either produce a wort containing this amount of malt sugar or if it be in excess, must have a means of eliminating it before fermentation. The principal prevailing methods employed in the brew house for the production of beer-wort are known as "decoction" and "infusion." Neither of them enables us to regulate the percentage composition of the wort in a manner required and desired despite the contrary assertions in several well known text books of brewing. The restriction of sugar production up to a certain degree may be successful with the "decoction" method, but only if very highly kilned malt and a very voluminous "lautermash" are employed, and if the diastasic action is interrupted and inhibited at the proper time while drawing off the wort. The formation of sugar during the "infusion" method can only be sufficiently restricted if a separation of thick and thin mash is accomplished after mashing in; if very high temperatures are employed during the mashing off; and the diastasic action is checked in time. The usual "decoction" and "infusion" methods with the ordinary brewing material do not therefore allow the required regulation of the sugar contents of the wort and a great many improvements may be made in this direction by careful and thorough investigation. I propose three new methods which may accomplish this result as follows:

1st: The conversion of the formed sugar in the wort extract into unfermentable products by means of caramelization. A large portion of the first wort is heated in a pressure kettle with 25 to 30 lbs. of pressure or exposed to a temperature of 105 to 110 R. This changes the malt sugar chemically into unfermentable wort extract. The caramelized wort is now added to the other wort in the kettle and boiled with hops as usual.

2nd: A large amount of the first wort is evaporated in vacuum pans to syrupy consistency. The separation of the malt sugar is accomplished in a special manner at this stage. The residual product is an extract poor in malt sugar which may be dissolved in water and added to the remainder of the wort in the kettle.

3rd: Concentrated beer worts poor in malt sugar or maltose

are produced; and these are used for krausening beers produced from worts low in malt sugar.

The methods described above are entirely new and much time will be required for perfecting them for practical use. Good results are expected from the tests made up to the present for regulating the ratio of the sugar to non-sugar in the wort and the alcohol content of beer. I have demonstrated in former publications by accurate figures the large losses, especially in American breweries, resulting from the high percentage of fermentable sugar in worts and the unnecessary destruction of valuable extract during fermentation. It is equally difficult to regulate the ratio of the soluble protein to the remaining extract in the wort and beer. The latter is principally determined during the malting process. Worts and beers rich in peptones can only be produced from fully grown malts, carefully handled on the floor and kiln. The assistance of the peptase is of course much desired during the mashing process, but it is present in only very limited quantities. The action of the peptase is much more energetic during the growth of the barley on the floor and the soluble albuminoids for the wort and beer are produced during that period. Two processes remove from the beer the coagulable and the soluble protein—the boiling of the wort and the activity of the yeast. A large percentage of coagulable albuminoids and all the valuable and useful enzymes of malt are eliminated during the boiling process and naturally lost to the finished beer. The protein not removed during the boiling process, is to a large extent, assimilated by the yeast and the resulting beer is low in albuminoids. In order to avoid the great loss of protein I have proposed, for the production of draught beer, to concentrate a portion of the first unboiled wort in a vacuum pan at a very low temperature, not above 40 R. After cooling and filtering, this wort is kept in the storage cellar and added to the beer at the time of racking. I have also tried to treat the last worts of lower gravity as regular beer-worts and to use the first worts of heavier gravity for krausening purposes and vacuum concentrations in order to be able to produce beers with high protein content and high nutritive value.

The tendency to produce highly fermented, stable, and bril-

liant beers is an obstacle to the manufacture of nutritive beers. There is nothing easier and simpler in practical brewing than the production of worts of 12 B. with a high sugar content and with an attenuation of 70 to 80 % in the cellar. Beers are most profitably made from such worts and are well suited for export.

There seems to be a strenuous effort on the part of the brewer to produce the largest possible quantity of finished beer in the shortest possible time and thus distribute the expense for brewing operations over the largest quantity of beer possible. Large brewing outfits are fast becoming a necessity and brew-house capacities of 500 to 600 barrels at a brew are common in the United States. It is only a question of time when we shall have the thousand barrel at a brew outfit. The manufacture of these enormous quantities of beer naturally develops the mechanical and technological part of the brewing industry more rapidly than the chemical. Chemistry of brewing is pushed to the background. But it is of the greatest importance to preserve the nutritive qualities of beer and if at all possible, to increase them. Chemical and physiological facts as well as the prohibition movement ought to stimulate the production of beers low in alcohol and rich in extractive substances. If the brewing industry is blind to the recognition of these facts, other industries will spring up for the purpose of resolving them. It is very probable that the brewing industry of the future will develop in two distinct ways:

1st: The production of beer on a gigantic scale in comparatively few breweries, with enormous development of trade, technology and intricate machinery.

2nd: The chemical technology of brewing will be rejuvenated; the originality of the beer brewer revived; and beers of a new and peculiar character and of greater nutritive value will come into favor.

Beer of good quality and moderate cost, beer as a food beverage for the great masses of civilized countries should ever be the watchword of our great brewing industry.